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ABSTRACT

Interactive computer-generated simulations that highlight psychological principles were investigated in this study in which 33 female and 19 male undergraduate college student volunteers of median age 21 matched line and circle sizes in six variations of Ponzo's illusion. Prior to working with the illusions, data were collected based on subjects' responses to control stimuli. Next, subjects were given two blocks of trials with the six illusions in each block. The first block presented each illusion once according to a random sequence without providing feedback as to the subject's accuracy. The second block presented the same illusions, but visual feedback was given as to the degree of deviation that existed following the subject's indication that the target and comparison figures were of equal size. Sex differences for accuracy of response were obtained, but overall significance by sex across all illusions was only borderline. Filled illusions had a greater effect compared to unfilled illusions. Both individually and averaged across conditions, line illusions caused higher error rates than circle illusions. Accuracy of response was not associated with time spent manipulating the comparison figures. In comparing the feedback to the nonfeedback condition, transfer of training effects were obtained. These results indicate that a microcomputer is uniquely suited for the development of the type of simulations examined in the study. (16 references) (Author/GL)

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Computer Generated Optical Illusions:

A Teaching and Research Tool

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Abstract

Interactive computer generated simulations that highlight psychological principles were investigated. Subjects matched line and circle sizes in six variations of Ponzo's illusion. Sex differences were obtained, but overall significance by sex across all illusions was only borderline, $t(50) = 1.69$, $p < .10$. Filled illusions had a greater effect compared to unfilled illusions, $t(51) = -4.34$, $p < .001$. Line illusions caused higher error rates than circle illusions, $t(51) = -4.73$, $p < .001$. In comparing the feedback to the nonfeedback condition transfer of training effects were obtained, $t(51) = 6.09$, $p < .001$. The discussion will examine the empirical significance of the findings, and pedagogical issues relevant to importing computerized simulations into course curriculum.

Computer Generated Optical Illusions:
A Teaching and Research Tool

Our purpose was to develop interactive computer simulations that could be used as instructional aids to highlight psychological principles. Furthermore, we wanted the simulations to serve as stand alone research endeavors. That is, in addition to supplementing classroom instruction we wanted our simulations to provide data that would be of wider empirical interest.

Social scientists have been involved in the design and use of computer resources since the development of the first digital processing machines. Within the last few years the microcomputer has had a revolutionary impact, making research possible that was once impractical (Rattenbury, Pelletier, & Klem 1984).

The study of optical illusions antedates formal recognition of psychology as an organized discipline (Goldstein, 1980). Despite wide spread interest in the study of illusions, there have been few studies which present optical illusions through an interactive computer medium

(Pittenger & Britton, 1985). For the purposes of this research project we translated the Ponzo illusion into a computer generated interactive format.

Method

Subjects.

Thirty three female and 19 male undergraduate college students voluntarily participated as subjects. Subjects received extra credit from instructors for participating in the experiment. They were allowed a choice between this experiment, other experiments and alternative extra credit activities. The median age of the subjects was 21 years.

Design and Procedure.

Subjects were exposed to six computer generated variants of Ponzo's illusion. Each of the illusions was presented on a horizontal axis rotation. Three of the variants used lines as comparison figures. Two of these three figures contained six internal radiating lines that originated from the vertex. The vertex was located on the middle left side of the computer screen. The figures with internal radiating lines will henceforth be referred to as filled illusions. There were two basic types of filled illusions - illusion in the background and illusion in the

foreground. In the filled line background illusion, the comparison and target figures appear as though they are in the background, in reference to the radiating lines. In the filled line foreground illusion, the comparison and target figures appear as if they are in the foreground. The other line variant, the unfilled lines, did not contain the six radiating lines and did not have a foreground or background effect. The remaining three variants used circles as comparison and target figures. The circles were presented in the same configurations as the lines - filled circle background, filled circle foreground, and unfilled circle. The center points, for both the target and comparison figures, were matched so that both lines and circles were located in the same position in the Ponzo frame. Also, the diameter of the circles and the length of the lines were equal.

The illusions were presented by means of an IBM compatible 80286 micro computer, using EGA color graphics. The program, written in GWBASIC, was designed to enable subjects to manipulate the size of the comparison figure. The subjects were able to cause changes in the size of the comparison figure by pressing the 'F5' key to make the figure smaller (circle diameter reduced or line shortened equally from both

ends) or pressing the 'F6' key to make the comparison figure larger. In all cases one key press changed illusion size by two pixels. In all cases, the comparison figure was the right most circle or line. The program also formatted and recorded social-demographic data which the subjects entered, as well as the degree of deviation each comparison figure was from the target figure (the left hand figure) and the time which expired while the subjects were working with each illusion variant.

Prior to working with the illusions, data was collected based on subjects' responses to control stimuli. The control figures possessed the same size and screen position as their illusion counterparts. This provided data as to the accuracy of their response to two circles or two lines that were not presented as part of an illusion. Next, they were given two blocks of trials with the six illusions in each block. The first block presented each illusion once according to a random sequence without providing feedback as to the subjects' accuracy. The second block presented the same illusions, but visual feedback was given as to the degree of deviation that existed following the subject indicating that he/she felt the target and comparison figures were of equal size.

Results

There was a significant effect for the illusions versus the accuracy of response to the test figures which were presented as a control condition. These differences held both overall ($t(51) = 8.24$, $p < .01$) and for each of the six individual comparisons. Sex differences for accuracy of response were obtained, but overall significance by sex across all illusions was only borderline, $t(50) = 1.69$, $p < .10$. Filled illusions had a greater effect compared to unfilled illusions, $t(51) = -4.34$, $p < .001$. For filled illusions, illusions in the background had higher mean error rates than illusions in the foreground; however, overall differences were not statistically significant, $t(51) = -1.60$, p N.S. Both individually and averaged across conditions, line illusions caused higher error rates than circle illusions, $t(51) = -4.73$, $p < .001$. Accuracy of response was not associated with time spent manipulating the comparison figures. In comparing the feedback to the nonfeedback condition, transfer of training effects were obtained, $t(51) = 6.09$, $p < .001$.

Discussion

First, it must be noted that our work is being presented with a two-fold purpose in mind. That is, the results and methodology will be discussed in terms of pedagogical relevance and empirical value.

Our results did not demonstrate a clear effect according to subject sex. The literature is equivocal in regard to the effects of sex on perception of illusions. Walter (1942) found an interaction between children's age and sex in their susceptibility to illusions. Dewar (1967) found females to have a higher illusion effect than males. Pandey & Jha (1984) found that frustration differentially affected perception of illusions in males and females. While several studies with children have found that girls are less accurate in their perception of illusions (Fraisse & Vautrey, 1956; Pressey & Wilson, 1978), research with adults has not generally supported these findings (Clem & Pollack, 1975). Given our results and the incongruities in the literature, further investigation of sex effects on the perception of illusions is considered mandatory.

Our findings concerning the more potent effects of filled illusions versus unfilled illusions is consonant with other findings reported in the literature (Beagley, 1985). We could find no other studies which

speculated as to the differential effects of a line versus circle Ponzo illusion. Considering our findings, this is a phenomena which could benefit from further investigation. Similarly, based on an absence of discussion in the literature and our suggestive findings, additional inquiry into differential effects of filled illusions with figures in the background versus filled illusions with figures in the foreground is warranted.

The findings concerning lack of association between time spent manipulating the comparison figure and accuracy of response were in part confounded by a sex effect. That is males, who were generally less affected by the illusions, also spent less time manipulating the comparison figure. Sorting out these variables awaits additional analyses and/or future research.

As previously stated, we were interested in developing these illusions for pedagogical utility. While we view the materials which we have developed to be more single purpose than certain other compilations of programs which are available (Anderson & Lane, 1987; Bharucha, Meike, & Baird; Pittenger & Britton, 1985) we feel confident that the materials we have developed can be adapted for use in a variety of classrooms. This is based on the fact that the discussion of illusions is a part of all

introductory courses in psychology; in the field of perception consideration of illusions is a primary content area (Goldstein, 1980); illusions and culture have been the topic of empirical investigations (Jahoda, 1966); and, psychopathology and the perception of illusions has been a topic of research (Weckowicz & Witney, 1960). Furthermore, a variety of status and social-demographic characteristics have been hypothesized to affect the perception of illusions (Matheny, 1972). The possibility of discussing these broad issues, as well as specific findings related to design and results, following hands on experience of students actively manipulating the test stimuli, make this a fertile area for development. Still, persons who would adapt these materials so they can be utilized in the classroom must be cognizant that limitations need to be considered and obstacles must be overcome (Eamon, 1986).

As a final note, practical considerations need to be taken into account when developing or using computer generated simulations for didactic purposes. For those new to the field of simulation development, a number of options must be weighed. Should they develop the programs themselves or use off-the-shelf demonstrations? What phenomena is best suited for computerized presentation? Which should

be picked for the development environment: micro or mainframe? What operating system should they choose? What hardware is best suited to their simulation? What programming languages do they need to learn or work with? These and other factors must be taken into account.

Based on our experience, we have no doubt that a microcomputer is uniquely suited for development of simulations such as we have discussed. Our initial work in this area was in mainframe applications, but issues of portability, inadequate graphics tools, lack of real time access, and other restraints inhibited development.

Within the microcomputer environment, choices as to hardware and operating systems should be based on access and familiarity. We have chosen the IBM for our hardware platform, but others may find MACINTOSH or other brands better suited to their needs. Previous work, by the authors, has led us to the conclusion that the APPLE platform is not well suited to the production of optical illusions at the level of resolution which we require for research purposes. Still, even here, the APPLE could be used as a demonstration aid. Particularly if one were working with illusions, such as the Top Hat illusion, which require less definition and detail. Furthermore, with the advent of the APPLE-GS this

line of computers now offers promise as a tool for the production of high quality graphics. While we decided upon DOS for our operating environment, others may want to consider UNIX or OS/2. Another decision which must be made is the video standard that is going to used. For the IBM, choices between CGA, EGA, VGA and Enhanced VGA need to be considered. We chose the EGA mode. This was based on the facts that the CGA mode does not offer adequate screen resolution, and at the time we started developing the illusions the availability of VGA cards and monitors was relatively restricted thus limiting portability. Another issue is programming language. For the illusions, as currently implemented by GW-BASIC, there are certain screen formatting characteristics that we are unhappy with; therefore, we are exploring options as to the best method for presenting these materials. We have developed illusions in PASCAL and have found that it offers more promise than the GW-BASIC programs as they are currently implemented. This is because with PASCAL one has the ability to address the VGA standard, the fact that the language allows programming which automatically senses and makes needed screen formatting adjustments based on the graphics standard used by the system, and the wider availability of antialiasing algorithms which

provide averaging formulas that give control of individual pixel intensities. However, we are still in the process of exploring other options. These include the use of graphics oriented shells, programs written in C language, and consideration of special purpose object oriented languages.

For those less interested in developing computer simulations on their own, only a limited number of the preceding issues are of direct relevance. Still, choice of hardware and what types of software to purchase are decisions of critical importance. It is quite easy to waste funds, which are generally in short supply for capital purchases, if one makes uninformed choices. Choices between products that promise computer applications that can be used to enhance instruction is extensive. The best choices for an individual's needs can be determined by visiting departments which regularly import computer demonstrations into the classroom, consulting with colleagues currently using computer simulations as instructional aids, getting on the mailing lists of software suppliers, consulting computer technicians experienced in this area, and reviewing relevant technical and popular literature.

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